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SUBJECT:STATEMENT ON U.S. PROGRAM FOR IAEA TECHNICAL
COMMITTEE MEETING ON PNES, JANUARY 20-24, 1975

1. DRAFT STATEMENT BY FLEMING WAS REVIEWED BY INTERAGENCY
GROUP IN WASHINGTON JANUARY 10. APPROVED TEXT FOLLOWS:

. . . . . STATEMENT ON THE U.S. PROGRAM

. . . . . E. H. FLEMING

IN PREVIOUS MEETINGS, U.S. PARTICIPANTS HAVE DESCRIBED PNE
RESEARCH AND DEVELOPMENT ACTIVITIES, INCLUDING PROGRESS
BEING MADE ON DETERMINING THE TECHNICAL AND ECONOMIC FEASI-
BILITY OF PNE STIMULATION OF NATURAL GAS PRODUCTION FROM
LOW-PERMEABILITY RESERVOIRS IN THE WESTERN UNITED STATES.
AT THIS MEETING, WE WILL REPORT ON TECHNICAL DEVELOPMENTS
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IN THE LAST TWO YEARS. WE WILL DESCRIBE THE 1973 RIO
BLANCO GAS STIMULATION EXPERIMENT AND PRESENT PAPERS ON OUR
OIL SHALE AND COPPER RECOVERY STUDIES. WE WILL ALSO PRESENT
PAPERS ON RADIOLOGICAL ASPECTS OF PNE GAS STIMULATION AND

NUCLEAR EXCAVATION PROJECTS. WHILE SOLID TECHNICAL PROGRESS CONTINUES, OUR PROGRAM IS STILL EXPERIMENTAL AND SOCIAL ISSUES ARE TENDING TO SLOW THE EFFORT.

ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

IN THE LAST FEW MONTHS, THE UNITED STATES HAS REORGANIZED THE ENERGY RESEARCH AND DEVELOPMENT FUNCTION WITHIN THE GOVERNMENT. THE U.S. ATOMIC ENERGY COMMISSION HAS BEEN DIVIDED INTO TWO PARTS: ONE PART RETAINS THE FUNCTION OF REGULATING THE NUCLEAR ACTIVITIES OF PRIVATE INDUSTRY AND IS NOW NAMED THE NUCLEAR REGULATORY COMMISSION; THE OTHER PART HAS BECOME THE NUCLEUS OF AN AGENCY WHICH CONSOLIDATES THE ENERGY-RELATED R&D ACTIVITIES (BOTH NUCLEAR AND NON-NUCLEAR) OF THE GOVERNMENT AND IS CALLED THE ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION, OR ERDA. THIS DEVELOPMENT WILL FACILITATE CONTINUING COST-BENEFIT COMPARISONS BETWEEN PNE AND ALTERNATIVE TECHNOLOGIES IN ENERGY-RELATED APPLICATIONS.

PNE STUDY IN PROGRESS

AN UP-TO-DATE STUDY IS NEARING COMPLETION IN THE UNITED STATES ON OUR PNE PROGRAM. THE STUDY, BASED ON THE EXPERIENCE OF BOTH INDUSTRY AND GOVERNMENT, INCLUDES AN ASSESSMENT OF THE PRESENT STATUS OF PNE DEVELOPMENT, WITH REFERENCE TO TECHNOLOGY, ECONOMICS AND REGULATION. IT ALSO INCLUDES A DETAILED EXAMINATION OF SELECTED CONTAINED PNE APPLICATIONS AND THEIR ALTERNATIVES , IN AN ATTEMPT TO PREDICT THE POSSIBLE EXTENT TO WHICH PNE TECHNOLOGY MIGHT PROVE PRACTICAL IN THE UNITED STATES. ITS PRELIMINARY CONCLUSION, BORNE OUT BY OTHER PAPERS TO BE PRESENTED BY THE U.S., IS THAT, IN GENERAL, MORE WORK IS NEEDED TO DETERMINE OR DEMONSTRATE THE UTILITY OF PNE APPLICATIONS. WE REGRET THAT THE STUDY HAS NOT BEEN COMPLETED IN TIME TO ALLOW ITS PRESENTATION AT THIS MEETING.

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APPLICATION STUDIES

AT THE THIRD IAEA PNE PANEL MEETING IN 1972, WE NOTED THAT NEW EVALUATIONS WERE BEING MADE OF THE POSSIBLE USE OF PNE FOR OIL SHALE AND MINERAL APPLICATIONS. TWO OF THESE STUDIES, INCLUDING PRELIMINARY ECONOMIC ESTIMATES, ARE REPORTED IN PAPERS TO BE GIVEN LATER IN THIS MEETING. WE HAVE NO ACTIVE PLANS TO CONDUCT PNE EXPERIMENTS TO TEST THESE APPLICATIONS. HOWEVER, LABORATORY AND NON-NUCLEAR EXPERIMENTATION RELATED TO THESE APPLICATIONS IS EXPECTED TO CONTINUE.

WE SHARE THE VIEW OF THE AGENCY AND ITS MEMBER STATES THAT

ECONOMIC AND HEALTH/SAFETY CONSIDERATIONS ARE OF GREAT IMPORTANCE IN DETERMINING THE UTILITY OF PNE TECHNOLOGY.

IN THIS REGARD U.S. PAPERS PRESENTED AT PAST MEETINGS HAVE INCLUDED INFORMATION ON THESE SUBJECTS, TO THE EXTENT THAT SUCH INFORMATION WAS AVAILABLE FROM OUR THEORETICAL AND EXPERIMENTAL WORK. AT THE CURRENT MEETING WE WILL PRESENT A PAPER ON THE RADIOLOGICAL IMPLICATIONS OF THE USE OF NATURAL GAS FROM WELLS STIMULATED BY PNE. WE WILL ALSO PRESENT PAPERS RELATING TO RADIOLOGICAL ASPECTS OF PNE EXCAVATION PROJECTS. THE U.S. CURRENTLY DOES NOT HAVE AN ACTIVE PROGRAM OF RESEARCH ON PNE EXCAVATION. HOWEVER, WE ARE INTERESTED IN IMPROVING INTERNATIONAL UNDERSTANDING OF THE ENVIRONMENTAL EFFECTS OF EXCAVATION PROJECTS, WHILE NOTING THE NEED TO OBSERVE INTERNATIONAL TREATIES AND UNDERSTANDINGS BEARING ON THE USE OF PNE TECHNOLOGY, INCLUDING IN PARTICULAR THE LIMITED TEST BAN TREATY.

PNE STIMULATION OF NATURAL GAS PRODUCTION

IN THE LAST TWO YEARS, THE U.S. HAS CONTINUED TO FOCUS MOST OF ITS PNE EFFORT ON NATURAL GAS STIMULATION. WE HAVE DESCRIBED THIS APPLICATION AT PAST MEETINGS AND WILL PRESENT THREE PAPERS AT THIS MEETING ON TECHNICAL AND ECONOMIC ASPECTS OF GAS STIMULATION IN LIGHT OF OUR MOST RECENT EXPERIMENTAL WORK. WITHOUT DUPLICATING IN DETAIL THE CONTENT OF THOSE PAPERS, I WOULD LIKE TO SUMMARIZE
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SOME OF OUR RECENT ACTIVITIES.

OUR THIRD AND MOST RECENT EXPERIMENT, RIO BLANCO, WAS CARRIED OUT ON MAY 17, 1973, AT A DEPTH OF ABOUT 1800 METERS IN RIO BLANCO COUNTY IN NORTHWESTERN COLORADO. ITS EXPLOSIVES WERE DESIGNED SPECIFICALLY FOR CONTAINED UNDERGROUND APPLICATIONS. THE ENTIRE EXPLOSIVE GROUP, WHICH CONSISTED OF THREE SEPARATE EXPLOSIVES, WAS SMALL ENOUGH IN DIAMETER TO BE LOWERED DOWN A STANDARD 10-3/4 INCH (26.88 CM) DIAMETER WELL CASING. ANOTHER IMPROVEMENT WAS THAT THE AMOUNT OF TRITIUM PRODUCED BY EACH EXPLOSIVE WAS REDUCED TO LESS THAN ONE-TENTH THAT OF THE 1971 RULISON EXPLOSIVE. THESE EXPLOSIVES, USED IN A COMMERCIAL SITUATION, WOULD CAUSE DOSES OF LESS THAN 1 MILLIREM PER YEAR TO RESIDENTIAL USERS.

IN RIO BLANCO, WE ELECTED TO DESIGN AN EXPERIMENT CONSISTING OF THREE THIRTY-KILOTON EXPLOSIVES SPACED ABOUT 120 METERS APART VERTICALLY IN ONE DRILL HOLE. THE YIELD AND SPACING OF THE INDIVIDUAL EXPLOSIVES WERE CHOSEN SO THAT THE FRACTURE ZONE OF ONE EXPLOSIVE WOULD INTERCEPT THE ZONE OF THE ADJACENT EXPLOSIVE. THE INTENT WAS TO

CREATE A RUBBLE VOLUME EXTENDING FROM THE TOP TO THE

BOTTOM OF THE GAS BEARING INTERVAL SELECTED.

THE THREE NUCLEAR EXPLOSIVES PERFORMED AS DESIGNED, AND DELIVERED THE PREDICTED AMOUNT OF ENERGY. THE DAMAGE CAUSED BY EARTH MOVEMENT WAS MINIMAL. WE ESTIMATED BEFORE THE EXPERIMENT THAT DAMAGE MIGHT TOTAL 50,000 DOLS AND WE HAVE PAID LESS THAN 40,000 DOLS FOR 111 VALID CLAIMS ON RIO BLANCO. ALL WERE FOR MINOR ARCHITECTURAL DAMAGE SUCH AS CRACKED PLASTER AND FALLEN CHIMNEY BRICKS. WHILE THERE WERE SOME MINOR PERTURBATIONS ON THE LEVEL OF WATER IN NEARBY WATER WELLS, WE FOUND NO EVIDENCE OF MAJOR EFFECTS ON AQUIFERS.

A DISAPPOINTMENT IN THE EXPERIMENT WAS THE FAILURE OF THE THREE FRACTURE ZONES TO OVERLAP. INSTEAD OF ONE INTER-CONNECTED FRACTURE REGION, WE HAVE FOUND THREE SEPARATE REGIONS WITH NO GAS FLOW FROM ONE ZONE TO ANOTHER. TWO UNCLASSIFIED

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REENTRY WELLS HAVE BEEN DRILLED INTO THESE REGIONS. THE ORGINALLY PLANNED WELL ENTERED THE TOP REGION. THE SECOND WELL ENTERED THE BOTTOM REGION. ANALYSIS OF THE GAS PRO-DUCED BY THESE WELLS HAS SHOWN THE PRESENCE OF KRYPTON-85 AND TRITIUM WITHIN PREDICTED AMOUNTS. IN ADDITION, CESIUM 137 AND STRONTIUM 90, TWO ISOTOPES FORMED BY THE NUCLEAR DETONATION, WERE BROUGHT TO THE SURFACE IN WATER PRODUCED WITH THE GAS FROM THE SECOND WELL. THIS WAS PROBABLY DUE TO THE LOCATION AT WHICH THIS WELL ENTERED THE BOTTOM DETONATION REGION. THE AMOUNTS OF THESE ISO-TOPES IN THE WATER ARE BELOW THE RADIATION CONCENTRATION GUIDELINES FOR WATER INTENDED FOR DISCHARGE IN A CON-TROLLED AREA. NEITHER OF THESE TWO ISOTOPES HAS BEEN DETECTED IN THE GAS.

RIO BLANCO AND OUR TWO EARLIER NUCLEAR STIMULATION EX-PERIMENTS HAVE DEMONSTRATED THAT PRODUCTION OF NATURAL GAS CAN BE INCREASED SEVERAL FOLD IN LOW PERMEABILITY FORMA-TIONS. EXECUTION OF THIS TECHNOLOGY ON A PRACTICAL SCALE, HOWEVER, INCLUDES FACTORS THAT ARE NON-TECHNICAL, SUCH AS PUBLIC ACCEPTANCE OF POSSIBLY LARGE NUMBERS OF EXPLOSIONS PER YEAR AND CONCERN OVER POSSIBLE ENVIRONMENT-AL CONSEQUENCES. OUR EXPERIENCE IN THE U.S. HAS SHOWN THAT THE RESOLUTION OF THESE QUESTIONS CAN BE DIFFICULT.

WE ARE ALSO CONSIDERING OPTIONS IN ADDITION TO THE USE OF PNES. CONVENTIONAL HYDRAULIC FRACTURING IS WIDELY USED IN THE U.S. OIL AND GAS INDUSTRY TO INCREASE FLOW FROM WELLS. IT IS DONE BY PUMPING A HYDRAULIC FLUID -- USUALLY WATER WITH ADDITIVES -- INTO THE WELL AT PRESSURES EX-CEEDING THE LITHOSTATIC PRESSURE. THE ROCK IS CRACKED,

AND THE GAS IS RELEASED INTO THESE CRACKS.

USUALLY SAND OR OTHER PARTICLE MATERIAL IS ADDED AS A QUOTE PROPPANT UNQUOTE -- IT KEEPS THE CRACKS PROPPED OPEN WHEN THE HYDRAULIC PRESSURE IS RELEASED. THERE ARE CURRENTLY SEVERAL INDUSTRIAL FIRMS IN THE U.S. THAT DO THIS TYPE OF FRACTURING COMMERCIALLY. HOWEVER, EFFORTS TO APPLY THIS CONVENTIONAL TECHNOLOGY TO VERY LOW PERMEABILITY FORMATIONS HAVE NOT YET BEEN SUCCESSFUL.

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THE TERM QUOTE MASSIVE UNQUOTE FRACTURING IS USED TO DESCRIBE THE PROCESS OF CREATING VERY LARGE FRACTURE ZONES AROUND BOREHOLES EXTENDING MANY HUNDREDS OF METERS. THE PROCESS REQUIRES MUCH MORE FLUID, PUMPING POWER AND PRESSURE THAN CONVENTIONAL HYDRAULIC FRACTURING, WHICH MAY EXTEND THE CRACKS ONLY TO A FEW TENS OF METERS. THE U.S. GOVERNMENT TOGETHER WITH THE PETROLEUM INDUSTRY IS CONDUCTING A PROJECT ON MASSIVE FRACTURING IN COLORADO, AT A SITE ABOUT ONE KILOMETER FROM THE RIO BLANCO SITE. IT IS PRODUCING DATA THAT WILL HELP US TO COMPARE NUCLEAR STIMULATION WITH MASSIVE HYDRAULIC STIMULATION. ALTHOUGH THE RESULTS TO DATE HAVE NOT BEEN PARTICULARLY ENCOURAGING, MASSIVE HYDRAULIC FRACTURING OR SOME OTHER NON-NUCLEAR ALTERNATIVE TO NUCLEAR STIMULATION MAY, IN SOME CIRCUMSTANCES, PROVE TO BE AN ATTRACTIVE WAY OF PRODUCING NATURAL GAS FROM LOW PERMEABILITY FORMATIONS. MORE EXPERIMENTS ARE PLANNED IN THESE NATURAL GAS FORMATIONS.
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